Utilization and Determinants of Agricultural Extension Packages by Smallholder Farmers: Evidences from Sinana District, Bale Zone, Oromia National Regional State, Ethiopia

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Abstract: This study was carried out to analyze agricultural extension package utilizations by smallholder farmers in Sinana District, Bale Zone of Oromia National Regional State. A cross-sectional study design was employed to collect data from 325 farmers through a simple random sampling technique. The quantitative data, obtained through survey, were analyzed using descriptive and inferential statistics; while the qualitative data, accessed through interviews and discussions, were analyzed thematically. The study found that 91.4% of the smallholder farmers were unable to access farm inputs such as agrochemicals, improved varieties, and farming machineries due to financial constraints. Besides, 93.2% of the farmers were not able to access agricultural inputs on time. The absence of integrated farm management, weak farmer-extension service linkage, and inconsistency between demands for agricultural inputs and supply posed challenges to channeling utilization of agricultural extension packages. There was also a statistically significant relationship among farmers' annual estimated income, farm size, household size, age, interaction, knowledge, and market access with the use of agricultural innovations such as application of chemical technologies, improved varieties, income diversification, and information accessed for agricultural extension packages utilization ($P<0.05$). Thus, institutionalization of integrated and collaborative engagements among stakeholders was suggested to improve the proper supply and utilization of agricultural extension packages in the study district.

Keywords: Agricultural extension; Determinants; Farmers; Sinana district; Utilization of extension services

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1. Introduction

Agriculture persisted to be the backbone of Ethiopian economy. The sector contributes 42% of Gross Domestic Product (GDP), covers 80% of the total employment, creates 90% of the foreign currency, and is the ultimate source of food for the nation (Birhanu and Colin, 2014; Derso, Elemo and Sewnet, 2016; Abdulhamid, Assefa, Atinkut and Dick, 2017). Food and Agriculture Organization[FAO] (2016a) also reported, in Ethiopia, since 2015 about 10.2 million people were food insecure; 2.2 million agriculturalists and herders crave humanitarian aid, and crop production declined by 50% to 90% in some areas and failed in others.

In Ethiopia, smallholder farmers produce more than 90% of agricultural yield on fragmented hectares of land. However, restricted agricultural technology choices, high price of agricultural inputs, undefined boundaries between extension services and local politics, drought, and climate change slowed agricultural productivity (Yokamo, 2020; Zerssa, Debela, Kim and Bettina, 2021).

As a result, agricultural extension service was already opted as among the strategies to enhance the productivity of smallholder farmers (FAO, 2015). Overcoming agricultural shocks and local food insecurity goes beyond increasing productivity as it requires optimizing the capacity of farmers to meet their own consumption and respond to local demands through their knowledge and skills (UN, 2015).

Since 1960, Ethiopia has witnessed the history of using agricultural extension services towards raising the living standard of poor farmers, create employment opportunities, encourage peasant participation, commercialize farming systems, and expand research stations to promote innovative thoughts in agricultural technologies, commercialize agriculture, and provide improved farm tools. The extension service packages comprise increased use of chemical technologies, provide credit service, and improved seeds. Likewise, the development of improved livestock species and products, conservation, and rehabilitation of natural resources, establishment of peasant associations, provision of cooperative services, and encouragement of private sector development and deployment of extension experts were other essential components of the extension services (Mekonnen, 2017; Berhane, Catherine, Gashaw, and Thomas, 2018; Yokamo, 2020).

The article, therefore, investigated the utilization of agricultural extension packages and the structural factors that determined access to the utilization of agricultural extension packages, in Sinana district, Bale Zone.

The research gap: Risks emanating from climate change, environmental degradation, and population growth constitute critically distressing contemporary agricultural practices (Feeding Africa, 2015; Zerssa *et al.,* 2021). In the past decades, recurrent drought events coupled with the poor farm management have resulted in declining agricultural production and food insecurity. Data obtained years back estimated that over 1.7 million children, pregnant women, and lactating women in Ethiopia required complementary nourishing, and many unreported were considered at risk of these predicaments (FAO, 2016b). In addition to droughts, there are also other factors that contributed to the vulnerabilities of agricultural sector including farm mismanagement, inappropriate agricultural practices, and unfit policies, and inadequate use of agricultural extension packages (Norton, Alwang**,** and Masters, 2010; Feeding Africa, 2015).

Hence, Ethiopia's agriculture has been heavily characterized by weak linkages between farmers, extension and research centers, and the top-down approach that dictate the delivery of services to the farmers (Derso *et al*., 2016; Berhane *et al*., 2018). More specifically, the monopoly over chemical fertilizers, inappropriate distribution of improved seeds, and engagement of extension experts in non-extension operations (Leta, Girma, Till, and Ann-Katharina, 2017), over dependency on agrochemical fertilizers (Bhandari, 2014), and climate change have been taking the lions share to jeopardize Ethiopia's agricultural extension systems (Derso, Gemeda, Henok, and Duguma, 2016).

Previous studies on the risks stemming out of the application of agricultural chemicals on agricultural productivity showed contradictory results. The study conducted by Guye (2015), in Guji Zone, Oromia National Regional State, Ethiopia revealed that nearly 70% of the farmers had

experienced and reported declining soil fertility on their farmland. This was further embedded in low extension program deliveries, weak farmer participation in decision-making process, inadequate training on the use of chemical fertilizers regardless of soil type, time and dosage. The same factors also accounted for soil infertility and farmers' uncertainty on agricultural extension packages. In contrast, Druilhe and Barreiro-Hurlé(2012) argued that more use of artificial fertilizer helps to ensure farm profitably, maintain soil fertility, and increase production to meet the ever-increasing food demand. According to Chandini, Kumar, Ravendra, and Om (2019), the utilization of chemical fertilizer raises the plant growth and vigor, thus mitigates food security problem of the world. However the plants grown through chemical fertilizers do not possess characters like good root system, shoot system, nutritional characters and also it would not get time to grow and mature appropriately. Chemically produced plants possess toxic chemicals which poses an effect on human health.

Regardless of those reported drawbacks, Mekonnen (2017) argued that Ethiopian agricultural practices have been characterized by the increasing utilization of chemical technologies including fertilizers, pesticides, and herbicides that negatively affect human health and the environment. Mekonnen further puts the paradoxical views on increasing agricultural yields and improvement of farmers' livelihoods. On one side, the Ethiopian government promotes the use of chemical technologies to increase agricultural production and productivity. On the other side, environmental commentators asserted that equivalent yield could obtain with customary agricultural practices. However, the study by Mekonnen did not cover as to why chemical-based agriculture has increased from time to time.

Technical challenges connected with the low skill of agricultural development agents, farmers' limited access to improved seeds, and policy-related challenges including state-based agricultural extension system comprises among the factors that constrained the Ethiopian extension system. Moreover, the extension system relies on and characterized by a highly structured top-down technology transfer system with little attention to problem-solving skills and technology adaptation. On the same note, the Ethiopian agricultural extension system has been thumped by high staff turnover, due to poor incentive structures and intolerant political systems (Leta *et al.,* 2017).

A study conducted on farmers' awareness of climate change by Derso *et al*. (2016) in the same research site, i.e. Sinana district, indicated that about 87.85% of sampled households reported on the presence of falling levels of crop production over the years. The survey results of the authors supported that causes accounting for the decline of crop production were climate change and variability (90.28%), soil infertility (6.39%), lack of technology transfer (2.56%), and market fluctuation (0.77%).

A study on the utilization of agricultural extension packages by farmers, benefits and uncertainties related to agricultural extension packages, challenges of smallholder farmers to use agricultural extension packages, and determinants of the utilization of agricultural extension packages continues to be sporadic. On the other hand, previously conducted studies on the theme mainly focused on selected aspects of agricultural extension packages like use of chemical fertilizer and improved seed utilization. Therefore, this study was conducted to investigate access and determinants of the utilization of agricultural extension packages by farmers, in Sinana district, Bale Zone, Oromia National Regional State. Accordingly, the study investigates access to and perceived benefits of agricultural extension package by farmers. It further explains the derivers of the utilization of agricultural extension packages in Sinana district.

Theoretical review: Innovation Diffusion Theory: The introduction of agricultural technologies in the agricultural extension system is expected to be wisely utilized by smallholder farmers. In this study, Roger's Innovation Diffusion theory was used by the authors to examine the determinants of the utilization of agricultural extension packages in the district. The theory underlines that the success of a given innovation depends upon its characteristics such as relative advantage, compatibility, level of complexity, trialability and observability. It also deals with questions of how decisions are made to

diffuse the newly invented or discovered innovations involving both idea and material components (Rogers, 1983). Hence, Roger's 'Innovation Diffusion theory had guided the fieldwork and analysis of this article while investigating farmer's views pertaining to the relative advantage, compatibility, complexity, trialability, and observability of the current innovations in agricultural extension services.

2. Research Methods

2.1. Study Setting

Sinana district is found in Bale Zone (Figure 1), Oromia National Regional State, Ethiopia. It is located at a distance of 460 KM to the Southeast of Addis Ababa. The district had a total of 134, 725, population out of which 67,144 were male and 67,535 were female in 2016/17. There were 19,637 rural households of which 17,370 were men and 2,267 of them were women-headed. Sinana district consisted of 20 Kebeles (Sinana District Agriculture and Natural Resource Office, 2016).

The district has favorable climate condition for farming livelihoods and inhabitations. It possesses 90% plain land and mid-highland, and 10% high land. The mean annual temperature ranges between 5^0C - 25 ^{0}C. The annual average rainfall is 1400-2800 mm. The district has bimodal rainfall. The total area of the district is estimated to be 1,705.87Km^2 (Diriba and Taye, 2020). From the total area of the land, 1190.23 km^2 (69.77%) is arable land, 192.71km^2 (11.29%) grazing land, 18.24km2 (1.06%) is urban and settlement areas, 123.24km^2 (7.28%) forestland, 0 km^2 (0%) bush shrubs, 2.1Km^2(0.12%) marshy and water body, and 179.35Km^2 (10.5%) is wasteland. In most parts of the district, the main rainy season *(*Meher) starts in June and ends in August or early September. This season is the main cropping season for different crops. Accordingly, barely, wheat, and maize are among the dominant crops which are grown in the study district (Sinana District Agriculture and Natural Resource, 2016).

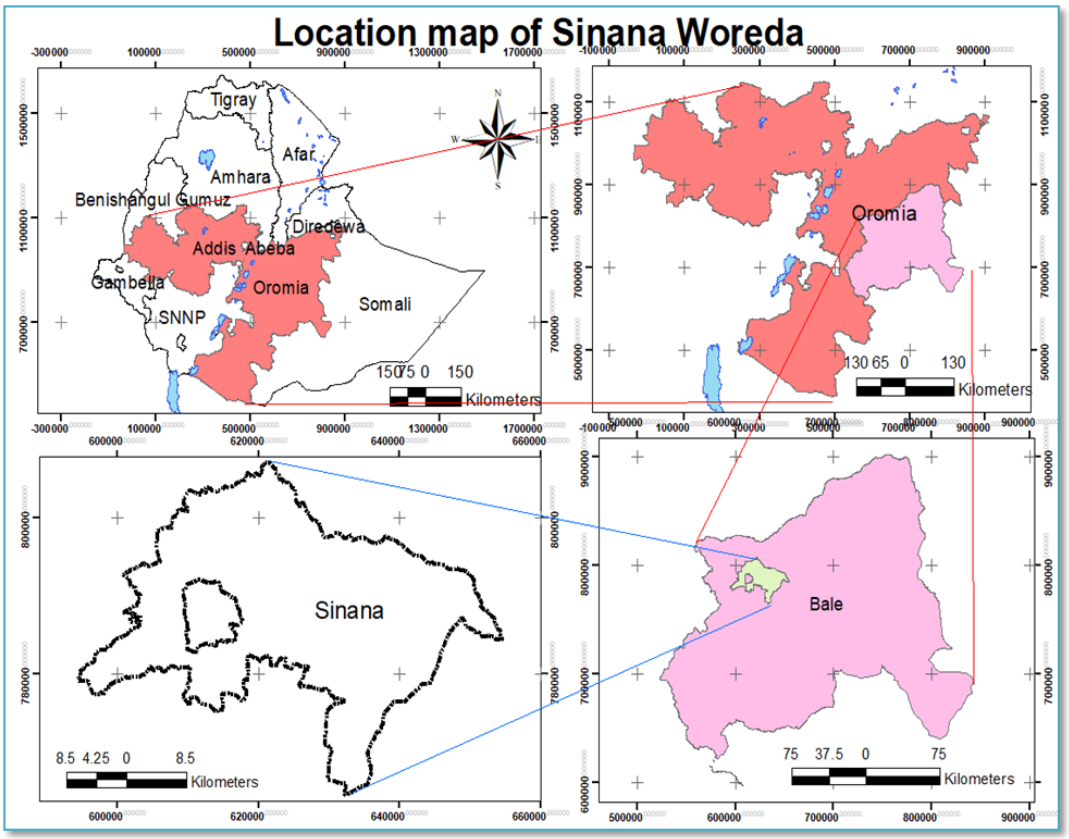

Figure 1: Location Map of Sinana District
Source: Ethio-GIS, 2003

2.2. Study Design

A cross-sectional survey was conducted from July 2018 to January 2019. This survey design was meant important to assess the themes of access, perceived benefits and determinants of the utilization of agricultural extension packages by farmers at a time. Hence, from the total of 20 rural kebeles in Sinana district, three Kebeles (Shallo, Obora, and Shewede) were selected purposively based on their experiences of yield productivity and the utilization of agricultural extension packages. After purposively selecting the three Kebeles, simple random sampling technique was applied to select the respective households. The sampling frame for this study was obtained from each Kebele administrations. Both the primary and secondary sources of data were used in the study.

The primary data were collected from 325 sampled farmers. The total sample size has been determined through Yamane (1967) sample size determination formula which is $n = \frac{N}{1+N(e)2}$. Where n = number of samples, N = Total population and e = Error tolerance (e= 0.05).

Note: The formula of proportionate to size ratio (p) was employed in the study to determine the sample quota of each selected Kebele.P= n/N. Where p= proportionate to size ratio, n= total sample and N= Total population (Endawoke, 2017). Hence, P=361/3708, p= 0.09757. This number is used to calculate the sample quota of each Kebele.

Table 1. Kebeles selected for the study

Kebele	N	n
Shallo	893	87
Obora	1784	174
Shewede	1031	100
	3708	361= 325 (90%)

Source: Survey, 2018

Besides, 7 (seven) in-depth interviews were conducted with smallholder farmers. Additionally, three FGDs were conducted with 24 discussants and representatives from the three kebeles. The key informant interviews were also conducted with another 7 (Seven) agricultural extension experts, farmers' cooperative union, and experts of the agricultural growth program coordination office.

The quantitative data were analyzed using both descriptive and inferential statistics. Hence, Chi-square test of association and binary logistic regression model were employed to examine the relationship between variables. With the Chi-square test, the authors predicted whether there was a statistically significant association between the categorical (nominal and ordinal) levels of variables or not. Likewise, binary logistic regression has been used to predict the determinants of agricultural extension package utilization by smallholder farmers. On the other hand, the qualitative data were analyzed using thematic analysis involving interpretation.

The standardized Cronbach's Alpha Reliability test was used to determine the reliability of the procedures used, and the Coefficient Score Test (0.7) was proved. Additionally, data from qualitative sources were triangulated to ensure the study's trustworthiness.

3. Results

3.1. Farmers' Characteristics

In descriptive terms, of the 325 surveyed farmers, 309 (95.08%) of them were male-headed and 16 (4.92%) of them were female-headed. With regards to the age categories, 165 (50.8%) of the farmers fall between 31-45 ages categories while 123 (37.7%) of the farmers fall in the age range of 46-60. The remaining farmers, 15 (4.6%) and 22 (6.8%), reported to be between 20-30 and 61-75 age categories, respectively. The minimum and the maximum age of the farmers were 23 and 75 years, respectively. And, the mean average age of the farmers was 45.16 with a standard deviation of 8.51,

which proved the presence of lower variations among the sampled farmers. With regards to their marital status, 95.1% were married, 0.03% not married, 2.8 % divorced, and 1.8 % widowed. This aligned with the presumption that farmers remain blind to marriage for socio economic and productivity purpose.

Concerning the educational status of the famers, while 137 (42.2%) of them were unable to read and write, 176 (54.1%) of them had attended primary school (Grades 1-8), and the remaining 11 (3.4%) and 1 (0.01%) of the farmers had attended secondary school (9-10) and college diplomas, respectively. The percentage of higher education attendance is lower as attended throw reported figures. Regarding the size of households, the majority, 226 farmers (69.5%) of them owned 4 to 6 household sizes. The mean average family size for the study respondents was 5.5 (±1.6) to the national average.

The descriptive analysis of farmers' economic livelihoods showed that agriculture leads as a dominant source of income and livelihood for the farmers. Accordingly, out of the total respondents, 25.8% (N=84) have 2 ha of farmland. Besides, 0.3 and 6.0 ha of farmlands registered as the minimum and maximum farm sizes, respectively.

3.2. Utilization of Agricultural Extension Packages by the Smallholders

The utilization of agricultural extension package depends upon services accessible in the district and used by smallholder farmers. The results obtained from the survey indicated that almost all of the study respondents used diverse agricultural extension packages.

Table 2. Types of agricultural extension packages (AEPs) used in the district

Types of agricultural extension packages used in the study area*	Frequency	Percent
1. Chemical technologies like fertilizers	303	95.6
2. Machinery (combiners and tractors)	290	91.7
3. Improved seeds and livestock breeds	130	41.3
4. Credit services	21	6.7
5. Land management training	9	2.9
6. Income diversification from crop production to other farming	27	8.6
7. Agricultural trainings	30	9.5

Source: Survey, 2018

*Note: * indicates the result from multiple responses*

As presented in Table 2 above, out of all 325 farmers, 303 (95.6%) of them have dominantly used agrochemicals like fertilizers, pesticides, and herbicides. Similarly, 290 (91.7%) of them used machineries like tractors and combines either to harvest their farm outputs or plow their land. Nevertheless, this does not validate that the farmers' use of machineries in each production season and for each type of crop on regular basis. Rather, they used these machineries based on the production status of their farm. Besides, 130 (41.3%) of them have used improved seeds and livestock species. Likewise, 21 (6.7%) of them have used credit services, 9 (2.8%) of them obtained farm and land management training, and 35 (10.8%) farmers had reported having access to time-based farming information from the agricultural extension experts.

Finally, of all farmers, 30 (9.5%) had reported on receiving different agricultural trainings on the advantages and the disadvantages of agrochemicals. This implied that, since the majority of farmers had relied on use of agro-chemicals, the utilization of the remaining agricultural extension packages such as income diversification, and the practices of integrated farm management seemed to be neglected.

3.3. Perceived Benefits of the Utilization of Agricultural Extension Packages

The farmers in the district constantly engaged in ways that help them to create innovative practices and improvements in their agricultural productivities. There were observations where some of them had already established knowledge on sorting out which agricultural innovations work and do not work for them. They often deploy their lived experiences in their cultures to forecast what would happen on their farm. Equally, it has been so easy for farmers to sort out the agricultural technology that possess relative practical advantages or not, in terms of technologies and other package. Over all, the perceived benefits of agricultural extension package utilization by farmers was presented as follows (Figure 2):

Out of the 325 farmers, 268 (79.7%) of them had indicated that they used Agricultural Extension Package (AEP) to increase their farm's productivity. Also, 23 (7.1%) and 17 (5.2%) of the farmers reported that they used AEPs to control crop and livestock diseases and improve their livelihoods, respectively.

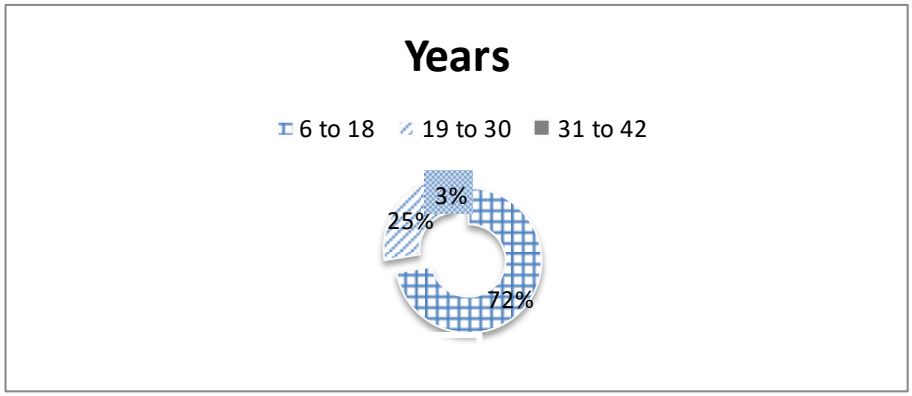

Figure 2: Years of using agro chemicals
Source: Survey, 2018

Figure 2 above showed that most of the respondents (72.4%) used agrochemicals for 6-18 years. The remaining 24.7% and 2.9% of the respondents used agrochemicals for 19-30 and 31-42 years, respectively. The above figure 2 also revealed that the maximum usage of agro-chemicals was 42 years and the minimum was 6 years. Besides, 16.27 years has been registered as the average mean of using agrochemicals with a standard deviation of 5.121.

Table 3. Farmers perception whether the existed AEPs possess advantages or not

Item	Response level	Frequency	%	Mean	Sd
Using agricultural extension possesses advantages in increasing agricultural production	Strongly agree	58	17.8	2.54	0.960
	Agree	85	26.2		
	Disagree	131	40.3		
	Strongly disagree	51	15.7		
	Total	325	100.0		

Source: Survey, 2018

For the data in Table 3 above, reclassification of values was made and given for each response as follows: 1 = strongly agree, 2=disagree, 3= disagree, and 4= strongly disagree. Based on this assumption, as the mean value approached 1 and 2, the farmers were more likely to have encouraging of practices. Nonetheless, as the mean value approached three or four, it is to mean that the farmers do not have a supportive view of the same.

Hence, out of 325 farmers, 143 of them (44%) confirmed that the existing agricultural extension services could create relative advantages for them. This becomes the case due to using various extension packages like agrochemicals, and improved varieties. On the reverse, 182 farmers (56%) explained that they did not get relative advantages from the utilization of agricultural extension package (M=2.54, Sd. = 0.960). This implied that there was no supportive inclination towards the application of agricultural extension packages including chemical fertilizers and the methods by which information about the newly introduced agricultural technologies were communicated to them.

Table 4. Farmers' views on the characteristics of agricultural extension packages (AEPs)

Items	Responses	Frequency	Percent	Mean	Sd.
Agricultural extension services such as improved seeds, chemical technologies, and machineries are provided with the purchasing capacity that farmers have**.**	Strongly agree	16	4.9	3.43	0.785
	Agree	12	3.7		
	Disagree	114	35.1		
	Strongly disagree	183	56.3		
	Total	325	100.0		
Agricultural extension services are manageable within the sphere of my knowledge and experiences.	Strongly agree	18	5.54	3.29	0.848
	Agree	29	8.92		
	Disagree	118	36.30		
	Strongly disagree	160	49.23		
	Total	325	100.0		
Agricultural extension services such as provision of improved seeds, and chemical technologies are compatible with my kebele's agro climate zone**.**	Strongly agree	29	8.9	2.70	0.810
	Agree	83	25.5		
	Disagree	170	52.3		
	Strongly disagree	43	13.2		
	Total	325	100.0		
It is easy to understand the utilization of each package of agricultural extension.	Strongly agree	8	2.5	2.93	0.734
	Agree	75	23.1		
	Disagree	173	53.2		
	Strongly disagree	69	21.2		
	Total	325	100.0		
Package of agricultural extension are trialable**.**	Strongly agree	21	6.5	2.79	0.829
	Agree	87	26.8		
	Disagree	153	47.1		
	Strongly disagree	64	19.7		
	Disagree Total	325	100.0		
Agricultural extension services such as improved seeds, chemical, and technologies are compatible with my farm soil**.**	Strongly agree	58	17.8	2.52	0.908
	Agree	75	23.1		
	Strongly disagree Disagree	157 35	48.3 10.8		
	Total	325	100.0		

Source: Survey, 2018

The majority of the farmers reported that the existing agricultural extension packages were not compatible with their financial capacity. Table 4 revealed that out of 325 farmers, 114 (35.1%) of them and 183 (56.3%) disagreed and strongly disagreed, respectively that the provided AEPs were purchasable within their financial capacity (M=3.43, Sd. = 0.785). The results obtained through the FGD also supported that the utilization of agricultural extension service requires paying back interest, access for inputs**,** and purchasing capacity of farmers.

Similar to the household survey, the FGD result revealed that there were different kinds of agrochemicals in use by the farmers in the kebele. Nonetheless, there was a discontentment concerning the price and quality of these chemicals. Despite the institutional operation of the farmers' cooperative union, the supply of the chemicals to farmers was so problematic. As a result, the union transferred these chemicals to the private sector. Then, the farmers were compelled to purchase these chemicals at expensive prices from private retailers where chemicals such as balance were sold for 2500 birr per litter. It was also not enough to have only this single chemical at a time to control crop figure farming risks. Farmers were expected to have another two or three chemicals to control crop diseases.

Discussants also denoted that some agrochemicals like Palace possess adverse effects on the growth of seeds. For instance, the chemical called "*Atlas*" damaged two hectares of a farmer's crops. This happened as farmers were unable to read instructions due to their educational low profile to use the chemicals' bottles, which exposed them to under dose or overdose utilizations**.** This was also attributed to the limited technical services of development agents.

3.4. Access to Agricultural Extension Packages

Table 5. Access to agricultural extension packages

Items		Frequency	Percent
Agricultural extension services like fertilizers, and improved varieties are accessible because, they are easily affordable	Yes	5	1.5
	No	320	98.5
	Total	325	100.0
Agricultural extension services are accessible because they are easily transportable	Yes	49	15.1
	No	276	84.9
Total		325	100.0

Source: Survey, 2018

Regarding access to the agricultural extension packages, the results indicated that 320 farmers (98.5%) reported that AEPs such as fertilizers, pesticides and herbicides, and improved seeds and animal varieties were not affordable to them. In addition, 276 (84.9%) of the farmers indicated that the absence of a road facility became one of the pronounced problems to access AEPs.

Picture 1: Photo of the all-weather road in the village of Shallo
Source: Authors, 2018

Additionally, shortage of agricultural inputs supply and delays in service delivery were among the challenges reported in the access and utilization of agricultural extension services. Hence, out of 325 farmers, 303 (93.2%) of them responded that agricultural extension services were not provided at the needed time. Equally, 312 (96%) of farmers reported that the amount of agricultural inputs provided to them could not satisfy their demand. This implied that there was inconsistency between demand for agricultural extension services and their supply. Nonetheless, the rest 33 farmers (10%) were able to get the packages of agricultural extension inputs at the needed time and amount.

On the other hand, having adequate knowledge of agricultural extension packages affects the utilization of AEPs. However, a gradual decline of farm productivity had occurred due to lack of adequate knowledge on the utilization of agricultural inputs. Evidence from in-depth interviews indicated that the rate and time of application were among the challenges for farmers in the district. In line with this, 314 (97.2%) farmers reported that they did not get orientations from agricultural extension experts about the adverse effects of some agricultural extension packages like chemical fertilizers. The 65 years old, male, farmer narrated that:

> There are agrochemicals that possess adverse effects on the growth of seeds. For instance, the chemical called Atlas damaged two hectare of our fellow farmer's crop. Farmers were unable to read instructions about the effects of the chemicals. Due to this reason, they used under dose, or overdose. Farmers needed the support of DAs, but we could not have this access. Farmers are struggling only for survival.

Lack of access to credit services and subsidies during seasons of crisis were considered as among the challenges in the utilization of agricultural extension packages. Similarly, a study by Getachew and Tigabu (2019) indicated that having appropriate information takes the lion's share in the utilization of agricultural extension packages. Table 6 presents the farmers' access to agricultural information.

Table 6. Information sources for agricultural extension services

Information sources	Frequency	Percent
Radio	201	61.8
Agricultural extension experts (development agents-DAs)	27	8.3
Model farmers	33	10.2
Radio, DAs, and model farmers	28	8.6
Radio and Television	7	2.2
Neighbor farmers	29	8.9
Total	325	100.0

Source: Survey, 2018

Table 6 above shows that among 325 of farmers, the larger proportions, i.e. 201 (61.8%), got access to farming information from Radio. Other farmers, 27(8.3%), 33 (10.2%), and 28 (8.6%) got farming information from agricultural extension experts, model farmers, radio, DAs, and model farmers, respectively. There were also farmers, 7 (2.2%) and 29 (8.9%) who claimed to access farming information from radio and television, and neighboring farmers respectively. Besides, the chi-square result also indicated that there was a statistically significant association between practices and information for the utilization of AEPs ($P<0.001$, or $P= .000$, $df=6$). Thus, these results revealed that having access to information for agricultural extension packages enabled farmers to have better understandings for diversified farming practices.

Information from Media provides advantageous to farmers. For instance, disseminating a given agricultural package through Media could be used to address several farmers at a time. But, to reach on mutual understandings, personal information exchange between farmers and experts plays a paramount role to minimize uncertainties on utilization of agricultural technologies. Overall, embedded in the innovation diffusion theory, communication channels had played important roles in

the advancement of using agricultural extension packages in particular and the overall improvement of the agricultural sector in general.

Additionally, strengthening farmers' extension interaction creates a valuable contribution to disseminate adequate agricultural information for farmers, to improve their diversified income sources, and increase farmers' awareness on the advantage and disadvantages of agrochemicals. Besides, improving farmers' literacy level was suggested to raise their exposure to agricultural information.

Table 7. Association of exposure for interactivity and agricultural extension packages utilization

Exposure variable	X^2	Df	Sig.
Farmer-extension interaction	12.95	1	0.012
Knowledge of AEPs	16.82	2	.000
Agricultural information	8.33	2	.016
Farmers educational status	22.645	4	.000

Source: Survey, 2018

In Table 7, the chi-square test of association indicated that there was a statistically significant association among farmers-extension interaction, knowledge of AEPs, agricultural information**,** and farmers' educational status with the utilization of agricultural extension packages ($P<.0.01$). The implication drawn was that the more farmer-extension interaction improved the more access to agricultural information by farmers to use agricultural extension packages gets improved.

3.5. Predicaments of Using Technologies in Agricultural Extension Packages

The limited participation of farmers in an agricultural extension system, lack of improved varieties, and farmers' fatigue to use unsustainable agricultural extension packages, unequal agricultural extension service delivery among farmers, and agricultural input-output obstacles were sources of complaints by smallholder farmers. Likewise, dependency over chemical technologies, accessibility problems, climate change, lack of credit services, and absence of implementing research findings were among the challenges of agricultural extension package utilization in the district. The study revealed that all of the aforementioned challenges had resulted in the following unenthusiastic consequences.

3.5.1. Declining trends in organic farming practices

The absence of integrated farming management resulted in the increased use of agrochemicals. The key informant interviews revealed that the gradual decline of conventional farming mechanisms and farmers' work habit led to over dependency on utilization of fertilizers. This was because farmers prefer to use less labor-intensive technologies. Though using organic fertilizer has a significant influence to increase soil fertility, the customary farming mechanism has been unable to create the required influence. One of the key informants underlined:

> The radical shift from using natural fertilizers like cow dung, compost to artificial fertilizers posed a jeopardizing effect on the growth of plants and soil fertility. It is known that using chemical fertilizers is preferable by farmers because, it saves labor, and, it is easy to apply. In contrast, the application of organic fertilizers requires commitment and extensive labor force. Whatever fertilizer is used, the ultimate goal is to renew the fertility of the soil and increase farm productivity. Dependency on chemical technology cannot be a guarantee; rather, it is important to follow integrated farming management. That is the concurrent application of artificial and natural fertilizers.

The quote demonstrated that using integrated farming management increased the fertility of the soil and agricultural production.

3.5.2. Loss of honey Bees

Based on the results obtained through household survey, 224 (68.9%) confirmed that the honey products declined, and entirely lost in some villages due to the application of pesticides and herbicides over farmlands. Tesfaye, Begna, and Eshetu (2017) also stated that honeybees were damaged due to flower poison. Nevertheless, the results gained through in-depth interviews and field observation showed that few farmers have reserved flower corner for honeybees can overcome the problem.

Picture 2: Photo of reserved beekeeping area
Source: Authors, 2018

3.5.3. Financial constraints

As the FGD discussants elaborated, unlike the past; contemporary agricultural activities require more input utilization due to the gradual decline of agricultural productivities. Chemical fertilizers, pesticides, herbicides, fungicides, and improved seeds and machinery were among the inputs that farmers expected to use. Nonetheless, since the utilization of these inputs would not go in line with farmers purchasing capacity, it has been difficult to use them in full packages. The results obtained through the household survey indicated that from 325 farmers, 310 (95.4%) of them responded that an increase in agricultural input prices obstructed them from effective utilization of agricultural extension packages.

Evidence obtained from one of the interviewees accounted on contemporary farming challenges as follows:

> Due to the gradual increase of prices for improved seed and agrochemicals, farmers in my village are unable to afford paying for agricultural extension packages. The only thing is the farmers who have financial capacity would have an access to use the packages of agricultural extension services. In the reverse, farmers without financial resource could not have an access to agricultural input utilization. Since there is no access to credit service, the farmers have been facing difficulty to use agricultural extension services. Similarly, the farmers expected to use more than two agrochemicals per single farm seed to get better agricultural yield. Expensiveness of inputs and lack of reasonable market price exposed farmers' life to risks.

This evidence, therefore, shows that financial capability is vital to get access to agricultural extension packages. Nevertheless, the farmers in the district were constrained to cover the high price of agricultural extension service packages.

3.5.4. Lingering sustainable agricultural development

The results obtained from the key informants indicated that the subsequent themes have been related to the ineffectiveness of agrochemicals like fertilizers, pesticides, herbicides, and fungicides.

i. **Rate of application**: Applying the recommended rate of chemicals on a given farming would lead to better control of farming diseases. However, using more than or less than the recommended dose of chemicals resulted in a probability of farm damage.
ii. **Time of application**: Once again, using chemicals without the recommended time affects the effectiveness of chemicals and affects the growth of seeds. The FGD discussants also confirmed this fact. The discussants explained that they observed seed damages resulted due to in appropriate use of chemicals.
iii. **Using unfitted chemicals**: Due to supply problem, and carelessness, farmers used non-recommended chemicals over their farms. There was a situation in which farmers used pesticides, herbicides, and fungicides interchangeably, or arbitrarily. There was a case of in-depth interviewees that narrated about one of his neighbors had lost three hectares of wheat because of the utilization of recommended chemicals.
iv. **Negligence of farming management:** based on the results of key informant interviews, lack of farming management by the farmers themselves was a challenge to effective utilization of agricultural extension services. Even though the farmers had participated in different kinds of trainings, they were unable to implement the essentials of the training they attended. This was due to the fact that farmers preferred to hire contract laborers and pass their working times in downtowns rather than to close to their farms. As a result, though the land owners have attended different kinds of farming trainings, usually, the untrained recruited laborers apply the chemicals over the farms. Hence, the farm owners could not supervise the rate and time of application, and chemical type.
v. **Mono-cropping and farming risks:** In principle, agricultural extension encouraged farmers to use crop rotation, or shifting cultivation. However, mono cropping is one of the drawbacks of farming risks in the district. As one key informant stated, mono-cropping was a cause for the expansion of crop disease like fungi, pests, and herbs. The gradual increase of crop disease summoned for increased application of multiple chemicals over a farm. This situation exposed farmers for unnecessary financial expenditure. Key informants recommended to follow crop rotation, or shifting cultivation because using crop rotation minimizes the application of excessive chemicals per farm. Hence, mono-cropping affects the sustainability of agricultural production since it results soil infertility.
vi. **Farmers' complaints:** The data gained from the interviewees showed that farmers have the interest to use various kinds of agricultural extension packages. Nevertheless, due to shortage of supply, late delivery of packages, increment of agricultural inputs, and poor extension service delivery, farmers had not benefited from the packages of agricultural extension services as expected. Similarly, they also noted that lack of accessible market to sell their agricultural outputs, high price of agricultural inputs and low outputs, and absence of farming training and less interaction between farmers and agricultural extension experts had constrained agricultural extension service utilization.

Furthermore, lack of access to credit service and inconsistency between the farmers' needs and the provision of agricultural extension services affected the farmers' productivity. Additionally, the interview results indicated that the top-down decision approach and absence of training on the advantages and disadvantages of some AEPs directly influenced the views of farmers on the relevance of agricultural inputs utilization. For instance, one of the farmers had briefly stated the provision of agricultural extension packages as follows:

> The interaction among the agricultural experts and farmers is too weak. The experts are not as such committed to serve us equally. The agricultural experts have given the ultimate priority to their own benefits. Consequently, we lack access to agricultural extension services, trainings and farming information. The chemical fertilizers and improved seeds have been distributed for farmers arbitrarily without studying the contexts of the soil and agro ecology. Even due to lack of awareness on how to use pesticides, herbicides, and antifungal, there were situations in which some farmers were exposed to asthma diseases.

3.6. Drivers of Income Diversification

Creating a diversified income source for rural people is one of the goals of development policies and strategies of the Ethiopian government. However, available evidence indicated that having an alternative income source for rural people helps to improve farmers' life and reduces pressure from nature's exploitation. Hence, the following analysis presented the predictors of income diversification in the study kebeles.

Table 8. Determinants of income diversification

Factors	B	S.E.	Wald	Df	Sig.	Exp (B)	95% C.I. for EXP(B)	
							Lower	Upper
Knowledge (1)	1.841	.480	14.693	1	.000	6.305	2.459	16.164
Age	.026	.034	.591	1	.442	1.026	.960	1.097
Household size	-.596	.143	17.355	1	.000	.551	.416	.729
lack of adequate market access (1)	1.488	.690	4.652	1	.031	4.427	1.145	17.107
Constant	2.675	1.516	3.111	1	.078	14.511		

Variable(s) entered on step 1: knowledge, age, household size, and lack of adequate information
Omnibus tests of model coefficients: Sig = 0.000 and classification table (over all percentage): 91.0%
Model summary (Nagelkerke R Square: 0.266) or -2 log likelihood: 145.947
Hosmer&Lemeshow test: Sig = 0.229 ($p > 0.05$)
X^2 test = 39.923 df = 4

Source: Analysis based on survey data, 2018

Table 8 indicates that there is a statistically significant association between income diversification and knowledge ($P<0.001$, or $P=0.000$, df=1). The likelihood odd ratio indicated that farmers who had better knowledge did engage in diversified income activities almost 6.305 times. In addition, there was a statistically significant association between income diversification and household size ($p<0.001$, or $p=.000$, df=1). The likelihood odd ratio was found to be 0.551. This implied that households with small family sizes engaged in income diversification activities 0.551 times.

Moreover, the data in the table above showed that there was a statistically significant relationship between income diversification and lack of adequate market access ($p<0.05$, or=0.031). The likelihood odd ratio implies that having access to a better market increases income diversification by 4.427 times. Likewise, there is a statistically insignificant relationship between income diversification and age ($p>0.05$, $p=.442$).

The estimate of Nagelkerke R-squared from the above table was 0.266, representing a weak positive relationship of 26.6% among the predictors (knowledge, age, household size, and lack of adequate market access) and the utilization of chemical technologies. The overall prediction success was 91.0%. Besides, the fitted model as Hosmer and Lemeshow test was statistically insignificant since $p>0.05$.

Table 9. Determinants of improved seed and livestock species utilization

Factors	B	S.E.	Wald	Df	Sig.	Exp (B)	95% C.I. for EXP(B)	
							Lower	Upper
Household size	-.259	.098	6.931	1	.008	.772	.636	.936
Age	.035	.019	3.416	1	.065	1.035	.998	1.074
Sex(1)	-.353	.678	.271	1	.603	.702	.186	2.655
inconsistency(1)	-.847	.397	4.556	1	.033	.429	.197	.933
Constant	2.493	.985	6.403	1	.011	12.098		

Variable(s) entered on step 1: Annually estimated Income, Household Size, Age, Sex, inconsistency between demand and supply
Omnibus tests of model coefficients: Sig = 0.000 and classification table (overall percentage): 59.6%
Model summary (Nagelkerke R Square: 0.278) or -2 log likelihood: 360.045
Hosmer&Lemeshow test: Sig = 0.148 (p >0.05), the model is feet
X^2 test = 74.329 df = 5

Source: Analysis based on survey data, 2018

Table 9 indicated that there was a statistically significant relationship between the utilization of improved seeds and livestock species and household size (p=.008, df=1). The Betta (β) value indicated that there was a negative relationship between household size and the utilization of improved varieties. It indicated that as the number of household sizes increases, the utilization of improved varieties decreases and larger families also tend to relay on their labor. The logic behind was that household with larger family size has forced to expend their money for consumption than the smaller one. Hence, the value of the above odds ratio indicated that those families with small household size have likelihood for the utilization of improved varieties 0.772 times than households with larger family size. The data in the above table also indicated that there was a statistically negative cause-effect relationship between the demand-supply of improved varieties and its utilization (p=0.033, df=1, β= -847) seems unrealized. This implied that when the supplies of improved varieties were consistent with the household farmers' income, interest, and agro-climate zone, there was a possibility to utilize different improved varieties; otherwise, the reverse is true.

In contrast, the above binary logistic regression analysis showed that there was a statistically insignificant interaction between household farmers' age and the utilization of improved seeds and livestock species (P>0.05, or P=0.065, df=1). Additionally, there was no statistically significant relationship between the sex of the farmers and utilization of improved varieties (P>0.05, or p=0.63, df=1). Therefore, it could be concluded that household size and demand-supply inconsistencies had affected the utilization of improved seeds and livestock species unlike that of age and sex.

Lastly, the estimate of Nagelkerke R-squared from the Table 9 was 0.278, representing a weak positive relationship of 27.8% among the predictors (annually estimated income, household size, age, and inconsistency) and the utilization of improved seeds and livestock species. The overall prediction success was 59.6%. Besides, the fitted model as Hosmer and Lemeshow test was statistically insignificant (p>0.05, p=0.148).

4. Discussions

As long as access to agricultural extension services accelerate improvements in the agricultural sector, the findings of this study unveiled that the farmers were expected to have the capacity to use and get access to agricultural extension packages with fair price, in needed amount, choice, and time. Hence, the packages in the agricultural extension system need to be available, affordable, and transportable to provide the services timely to the farmers. Contrary to the practices at the grassroots, the study found

that 99.4% of the farmers utilized different agricultural extension packages (AEPs). It was also indicated that factors related to differences in preference and accessibilities were among the identified reasons for the variation in agricultural extension packages utilizations among the household farmers of Sinana district.

In the same manner, Rogers's Innovation Diffusion theory (1983) asserts that the successfulness of a given innovation depends on its relative advantages, compatibility, complexity, trialability, and observability. These specific innovation characteristics were highly considered by the smallholder farmers to adopt or reject a given agricultural package.

The findings depicted that the existing agricultural extension packages were not compatible with their financial capacity. It was also reported that the gradual increase of prices in agricultural input becomes the major challenge in AEP utilization. Only a few household farmers reported that lack of finance was not challenging them to get certain kinds of AEP. The study revealed that lack of transport accessibility and absence of demand-driven supply also taken as one of the big challenges in agricultural extension packages utilization.

The packages of agricultural extension services provided in the district were not easily understandable and treatable (M=2.79, Std= 0.829). The result indicated that the provision of improved seeds and agrochemicals could not be compatible with the condition of farm soil and agro ecology.

Absence of farmers' participation in an agricultural extension system, low access to improved varieties and poor extension service provision; the way agrochemicals practiced by farmers, domination of mono-crop farming at the cost of shifting cultivation and integrated farm management, weak linkages between farmers, extension workers; and researchers and absence of equipped farmers' training centers were the challenges that farmers had been facing altogether. Besides, accessibility problems, climate variability, lack of credit services to have an access to AEPs, absence of reasonable market prices, problems related to farmers' union, corruption, and weak management systems were among the identified challenges for poor agricultural extension package utilization. Agreeing to the present findings, Derso *et al.* (2016) and Leta *et al.* (2017) argued that farmers in Ethiopia lack access to agricultural extension packages utilization due to inadequate delivery of agricultural extension services. Hence, restricted technology choices, lack of commitment, weak linkage among farmers and agricultural extension experts, and the monopoly of centrally planned agricultural extension systems were among the factors that hindered the effective utilization of agricultural extension services.

The study revealed that farmers had gone to complaining about implementation of recommendations, lack of committed agricultural extension experts, arbitral distribution of agrochemicals, inconsistency between supply and demand, and discrepancy between agricultural inputs and outputs, and fluctuation of climate condition were among the factors that affect the utilization of AES.

The Ethiopian agricultural extension system had been highly challenged by different causes like growing dissatisfaction of farmers toward agricultural extension services (Mekonnen, 2017). In addition, increased prices of agricultural technologies, high input, and low productivities, absence of farmers' contribution in the decision-making process and absence of private sectors in chemical fertilizer distribution (Guye, 2015; Leta *et al.,* 2017) were from among the challenging factors of Ethiopia's agricultural extension system.

Likewise, this article also confirmed that analogous constraints to the agricultural extension system were commonly prevailing in Sinana district too. These would highly hinder the achievement of sustainable development in agricultural extension systems. Available empirical evidence indicated that inappropriate application of chemical technologies often resulted in human health effects (Bhandari, 2014; Kumari, Raja, and Narasimha, 2014; Pretty, 2017).

The challenges of agricultural extension packages including the problems of access to agricultural inputs accelerated the gradual decline of organic farming due to the absence of integrated farm management, increase in chemical-dependent farming, domination of mono-cropping farm, and

decline of agricultural productivity. The monopoly of chemical fertilizers, inadequate distribution of improved seeds (Leta *et al.,* 2017), over dependency on agrochemical fertilizers (Bhandari, 2014), and climate change were among the challenges of Ethiopia's agricultural extension (Derso *et al.,* 2016). According to Guye (2015), about 70% of farmers have experienced declining soil fertility on their farmland. The application of herbicides and pesticides, and lack of extension services were among the identified challenges of bee-keeping practices in the Bale Zone (Bekele, Dessalegn, and Mitiku, 2017). This implied that the ecosystem of Sinana district suffered from lack of awareness and inadequate utilization of extension packages.

Regarding the determinants of agricultural extension packages utilization, farmers financial capacity, knowledge; household size, and farm size were among the factors that determine the utilization of different agricultural packages ($P<0.001$). Finally, institutional factors like weak farmer-extension agent interaction, inconsistency of extension service provision, lack of market, lack of participation and information accesses were among the determinants of AESs utilization in the district.

5. Conclusions and Recommendations

5.1. Conclusions

In Sinana district, the limited implementation of agricultural extension package services exposed smallholder farmers to different farming-related risks such as production decline, absence of integrated farming management, high agricultural input with low output, and domination of mono farming activity.

In other words, lack of compatibility between smallholder farmers' demand and agricultural technologies affects the improvement of the agricultural production in the district. Moreover, lack of better access to agricultural extension packages had affected the productivity of farmers. The absence of well-integrated and participatory extension service delivery was also one of the challenges in the implementation of agricultural extension services strategies.

5.2. Recommendations

Sustainable agricultural extension system calls for motivating farmers to practice diversified farming activities, enhancing the practices of integrated farming management to overcome the problems of farming. Besides, strong cooperation among farmers, agricultural extension service providers, research institutes, non-governmental organizations need to be created to bring agricultural transformation in the district. In addition, agricultural inputs with quality, time-oriented and reasonable prices need to be supplied consistently with the farmers' demand.

Policymakers and practitioners should also consider the social and other aspects of the agricultural sector where the policy is designed to be implemented. Finally, future experiencing studies are needed to uncover the risks of small-holding farmers' utilization of agro-chemicals in the study area, in particular and Ethiopia, in general.

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